parallel of 53° (through Cromer, in Norfolk) and the north coast of Holland and Hanover, are not sensibly different from what they would be if the passage through the Straits of Dover were stopped by a barrier.

2. The main features of the tides (rise and fall and tidal streams) throughout the British Channel west of Beachy Head and St. Valery-en-Caux do not differ much from what they would be if the passage through the Straits were stopped by a barrier between Dover and Cape Grisnez (Calais).

3. A partial effect of the actual current through the Straits is to make the tides throughout the Channel west of a line from Hastings to the mouth of the Somme more nearly agree with what they would be were there a barrier along this line than what they would be if there were a barrier between Dover and Cape Grisnez.

4. The chief obviously noticeable effect of the openness of the Straits of Dover on tides west of Beachy Head is that the rise and fall on the coast between Christchurch and Portland is not much smaller than it is.

5. The fact that the tidal currents to the westward commence generally an hour or two before Dover high-water and to the eastward an hour or two before Dover low-water instead of exactly at the times of Dover high- and low-water, is also partially due to the openness of the Straits of Dover.

6. The facts referred to in Nos. 4 and 5 are wholly due to three causes:—

(1) The openness of the Straits of Dover.

(2) Fluid friction (in eddies along the bottom and in tide-races).

(3) Want of absolute simultaneity in the time of high-water across the mouth of the Channel from Land's End to Ushant.

It is certain that (1) is very sensibly influential; it is probable that (2) is also so; it is possible, but scarcely probable, that (3) is so. Without farther investigation it would be in vain to attempt to estimate the proportionate contributions of the three causes to the whole effect.

7. It is certain that were the Straits of Dover barred, and were the water frictionless, there would be nearly a perfect *nodal line* [with but a small deviation from perfect nodality because of the influence of cause (3)] across the Channel from somewhere near St. Alban's Head on the English coast to somewhere near Cape La Hague or Cherbourg or Cape Barfleur, on the French coast, that west of this line the time of low-water, and east of this line the time of high-water, would be exactly the same as the time of high-water at Dover; and that throughout the Channel the water would be flowing eastwards while the tide is rising at Dover, and westwards while the tide is falling at Dover.

8. (Understanding from Fourier's elementary principles of harmonic analysis that all deviations from regular simple harmonic rise and fall of the tide within twelve hours are to be represented by the superposition of simple harmonic oscillations in six-hours period, and four-hours period, and three-hours period, and so on—like the "overtones" which give the peculiar characters to different musical sounds of the same pitch.) The six-hourly oscillation which gives the double low-water at Portland and the protracted duration of the high-water at Havre[1] is probably in part due to the complex-harmonic character of the current through the Straits of Dover; that is to say, definitely, to a six-hourly periodic term in the Fourier-series representing the quantity of water passing through the Straits per unit of time, at any instant of the twelve hours.

The double high-water experienced at Southampton, and in the Solent, and at Christchurch and Poole, and still further west, generally attributed to the doubleness of the influence experienced from the tidal streams on the two sides of the Isle of Wight, seems to have a continuity of cause with the double low-water at Portland, which is certainly allied to the protracted high-water of Havre—a phenomenon quite beyond reach of the Solent's influence. It is probable, therefore, that the double high-water in the Solent and at Christchurch and Poole is influenced sensibly by the current through the Straits of Dover, even though the common explanation attributing them to the Isle of Wight be in the main correct.

WILLIAM THOMSON

OUR ASTRONOMICAL COLUMN

OCCULTATIONS OF STARS BY JUPITER'S SATELLITES.—Mr. Tebbutt, of Windsor, N.S.W., writes to the *Astronomische Nachrichten*, that on October 5 he made "an observation, which, if not without a parallel in the annals of astronomy, is at least an extremely rare one." A star of the ninth magnitude was occulted by the first satellite of Jupiter, under sufficiently good definition to allow of the latter being seen with a round disk: the occultation was not quite central, the star appearing to pass behind the northern portion of the disk. From the approximate position assigned to the star by Mr. Tebbutt, it must have been No. 20236 of Oeltzen's Argelander, called 9·10 mag.

The observation is not quite without a parallel, though doubtless a rare one; Flaugergues of Viviers (who, by the way, was the first discoverer of the great comet of 1811, as Mr. Tebbutt was also discoverer of the grand comet of 1861) observed an occultation of a small star by the third satellite of Jupiter on the morning of August 14, 1821, as described in a letter to Baron de Zach, which will be found in his *Correspondance Astronomique*, vol. v. p. 456. Flaugergues had proceeded to his observatory to watch an eclipse of the satellite, and on looking at Jupiter he remarked a small star near it; the satellite approached the star, and at 1h. 47m. sidereal time, appeared to touch it; at 1h. 56m. 52s. the star was no longer visible; at 1h. 59m. 10s. the satellite in its turn vanished in the shadow of the planet. He continued at the telescope some time after its disappearance, hoping to witness the star's emergence, but twilight soon became too strong. Perhaps now that the phenomena of Jupiter's satellites are more closely watched than formerly, such observations may become somewhat less exceptional; Mr. Tebbutt is doing good service in the observation of the phenomena of the Jovian system, as is also another Australian observer, Mr. Todd, at Adelaide.

OCCULTATION OF 64 AQUARII BY THE PLANET JUPITER.—It appears certain that the star 64 Aquarii, generally rated $6\frac{1}{2}$ magnitude, will be occulted by the planet Jupiter on September 14, 1879. The apparent place of the star for that day, taking its mean place from the Greenwich catalogue of 1864, with Mädler's proper motion, will be in R.A. 22h. 32m. 58·45s., N.P.D. 100° 39′ 0″·6, whence, with the position of Jupiter from Leverrier's tables, as given in the *Nautical Almanac*, the apparent conjunction will take place at 1h. 53m. Greenwich mean time, when the geocentric difference of declination is 9″·8. The polar semi-diameter of the planet is 23″·0 and its horizontal parallax 2″·2. It is clear, therefore, that there must be an occultation. The phenomenon will be most favourably witnessed at the Australian observatories; at Melbourne, for instance, the planet will be only a quarter of an hour from the meridian and 27° from the zenith.

THE CONJUNCTION OF MARS AND SATURN, JUNE 30, 1879.—The *Nautical Almanac* notifies a conjunction of these planets on June 30, 1879, at 8h. G.M.T., with Mars only 1′ to the north of Saturn. It is not without interest

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[1] At Havre, on the French coast, the high-water remains stationary for one hour, with a rise and fall of three or four inches for another hour, and only rises and falls thirteen inches for the space of three hours; this long period of nearly slack water is very valuable to the traffic of the port, and allows from fifteen to sixteen vessels to enter or leave the docks on the same tide.

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to examine this near approach more closely, particularly as Bouvard's Tables of Saturn were used for 1879. According to Leverrier's Tables, the position of Saturn from Bouvard requires corrections of about + 1·79s. in Right Ascension, and − 0″·4 in Declination; whence, with Leverrier's place of Mars the conjunction in right ascension occurs at 8h. 3·7m. G.M.T., and at this time the geocentric difference of declination is 1′ 29″·0. The apparent semidiameter of Mars (taking 9″·45 for the diameter at mean distance) is 4″·46, and the apparent polar semi-diameter of Saturn, 7″·83; the horizontal parallaxes, 8″·36 and 0″·93 respectively. Hence it is evident that there will be no approach to an occultation. At conjunction the planets will be below the horizon in this country, but will be near the meridian at our Australian observatories; there, however, the least distance between the south limb of Mars and the north limb of Saturn will, according to the Tables, exceed a minute of arc. Mr. Marth has pointed out that the last close conjunction of Saturn and Mars took place on April 18, 1817; the *Berliner Jahrbuch* for that year gives the time of conjunction at 7h. M.T. at Berlin, with Mars 1′ S. of Saturn.

An occultation of Saturn by Mars, so far as we know, has not yet been put upon record, nor suspected before the invention of the telescope. The earliest mention of a near approach of the two planets is found in the Chinese annals during the latter days of the 10th moon, A.D. 27; on this occasion Mars, Jupiter, and Saturn were all situate within about 2° from the bright star Regulus; and the same annals record that on July 23, A.D. 143, Mars was very near to Saturn.

BIOLOGICAL NOTES

NATURAL SELECTION AMONG LARVAL SALAMANDERS.—Every case illustrating survival of the fittest has its own interest, as well as its bearing on general laws. The New England salamanders lay large numbers of eggs attached to water plants, and the larvæ are very interesting to watch. In a group that was studied recently, cannibal tendencies soon developed, the stronger eating off the gills of the weaker, at the same time being able to protect their own, within a week or ten days after hatching; these cannibals were fifty per cent. larger than their brethren, and, soon waxing bolder, they began to swallow them bodily. After ten days of the results of such feeding, they were ten or twelve times the size of such weaker brethren as were still left alive. Thus they rapidly developed and passed out of the gill-bearing stage. See Mr. S. F. Clarke, in *American Naturalist* for September.

THE MUSCLES OF THE MAMMALIAN FOOT.—Dr. D. J. Cunningham (*Journal of Anatomy and Physiology*, October, 1878), after dissecting the manus and pes of a large number of mammals, finds that the typical arrangement of the intrinsic muscles of the foot is the same as in the hand, and that this is best seen in certain marsupials. In these animals the muscles are disposed in three layers (1) a plantar layer of adductors; (2) an intermediate layer of short flexors; and (3) a dorsal layer of abductors. Deviations from the type may take place by suppression or by fusion of certain elements of the different layers. Fusion of the members of the intermediate and dorsal layers is very common. The presence of an opponens muscle is not accounted for in the foregoing disposition. When present Dr. Cunningham regards it as derived most commonly from the short flexor, but in many of the carnivora it proceeds from the plantar layer. Further, it is found that in many animals the relation of the intrinsic muscles to the metatarsal bones, both as regards their origin and position, corresponds with transitory conditions in the foot of the human embryo. The adult dog agrees exactly with the first stage of the human fœtus in the relation of the intrinsic pedal muscles to the metatarsals; the bones are closely compressed together, and the muscles are entirely plantar in position.

SENSITIVE ORGANS IN ASCLEPIADACEÆ.—Robert Brown gave it as his opinion, based on experience, that fertilisation in this family of plants depends largely upon insect agency. Dr. J. G. Hunt has recently published observations on *Stapelia asterias*, whose flower has an extremely disagreeable and animal odour, which appears to attract many flies. Under observation flies were seen eagerly applying their tongues all over the petals and essential organs, apparently eating, with an almost intoxicating relish, the excretion covering those parts. This banquet was indulged in with safety until their tongues came in contact with one of five black spots situated near and alternate with the stamens, when, with amazing quickness, the fly was seized and firmly held by the tongue—a hopeless prisoner. Now a struggle commenced, and if the fly was small and not vigorous, he was retained; if large and strong he escaped, dragging away the black spot and also the pollen-masses, two of which are attached to each trap. The adhesion of the fly's tongue is not caused by any viscid liquid, but by a capital pair of blades, which, when touched lightly by a fly, or even a hair, close instantaneously, and secure the object. Two species of Asclepias have been examined by Mr. Edward Potts, and in these he finds that each anther has a pair of sacks or cases in which the pollen masses are suspended so as to make their withdrawal easy. They are closely adherent to the stigma. The sensitive glands are placed in shallow depressions upon the perpendicular columnar ridges of the stigma. The fact of the removal of the pollen masses by insect agency is well known; the question to determine was whether the glands had anything to do with the removal. Mr. Potts caught houseflies and held them by their wings above the flowers, allowing their feet to scramble over them. Almost immediately one or more of these would become ornamented with groups of the glands and pollen-masses, which clung so closely that their later struggles and rubbings failed to detach them. When separate hairs were directed on to a gland, the latter instantly contracted and clung to the hair, tearing itself loose from the stigma, and carrying away the pollen masses with it. On one of the species of Asclepias Mr. Potts noticed three flowers which, in addition to its own complete anthers, had one other sensitive gland and its attached pollen-masses, inserted under the edge of a normal anther, and against the sloping lower surface of the stigma. The development of these adventitious pollen-masses was traced till they put forth a profusion of pollen-tubes into the stigma, and the ovaries began to increase in size. Dr. Asa Gray mentions self-fertilisation as occurring in this genus by a similar growth of bundles of pollen-tubes penetrating the stigma at its lower extremity. But here in the presence of the foreign pollen-masses none of the home-grown ones had put forth pollen-tubes. It is conjectured that the maturity of the pollen-masses is reached so late that the stigma of the same flower is frequently unsusceptible. But if the pollen-masses from earlier flowers are removed by insects and lodged upon another just opened, they develop pollen-tubes, and cross-fertilisation ensues. Thus the sensitive glands are not for capture of insects, but to favour cross-fertilisation. (*Proceedings*, Acad. Nat. Sci. Philadelphia, 1878).

THE INHALATION OF PHOSPHURETTED HYDROGEN.—Dr. T. B. Henderson, of Glasgow (*Journal of Anatomy and Physiology*, October, 1878), has investigated the physiological effects of the inhalation of phosphuretted hydrogen gas, by inclosing an animal in an air-tight chamber of known capacity, and subsequently introducing into this a given quantity of the gas. In the first experiment a strong rat was placed in an atmosphere consisting almost entirely of phosphuretted hydrogen, and death

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